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1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

TECHNICAL REPORT 84-6

materials bureau technical services division

A CONSTRUCTION REPORT ON REESTABLISHING LOAD TRANSFER IN CONCRETE PAVEMENT TRANSVERSE JOINTS

SEPTEMBER, 1984

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TECHNICAL REPORT 84-6

A CONSTRUCTION REPORT ON REESTABLISHING LOAD TRANSFER IN CONCRETE PAVEMENT TRANSVERSE JOINTS

by

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MATERIALS BUREAU
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NEW YORK 12232

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- ABSTRACT -

In 1983, the New York State Department of Transportation constructed a project to rehabilitate a severely faulted concrete pavement. Rehabilitation included; partial pavement grinding to taper off faulted transverse joints, reestablishing structural integrity at some of the faulted joints by retrofitting load transfer devices, and resealing all transverse and longitudinal joints.

Interstate 84, near Ludingtonville, New York, was the location of this experimental 3.6 mile contract. The original pavements were 15 and 17 years old at the time of rehabilitation. Retrofitting load transfer devices was the "experimental part" of this grinding and resealing contract. A total of 292 University of Illinois load transfer devices were installed in 78 transverse joints. The University of Illinois devices were placed in groups of 3 or 4 per joint. In addition, 336 I-beam dowels were placed in groups of 4 or 8 per joint. Both load transfer devices were bonded to the original pavement slabs using polymer primer and polymer concrete. Traffic was allowed over the load transfer devices after the polymer concrete had cured for two hours.

The performance of both retrofitting methods varies. The dowel installations are continuing to provide load transfer after ten months in service and no debonding of the polymer patched areas, from the original pavement slabs have been noted. The University of Illinois load transfer devices had an early 16% debonding rate caused by poor polymer concrete consolidation and insufficient primer adhesion. The remainder of these units are continuing to provide load transfer over the same time period. Long term performance monitoring of the retrofitted load transfer devices will be continued.

INTRODUCTION

Hundreds of miles of Portland cement concrete highways were built in New York State under the intensive building programs of the late 1950's and the 1960's. During this period, many of our primary routes were constructed, including a substantial portion of the interstate system. These highways have served the public well, but many have exceeded their design lives and now require rehabilitation. Presently the Department is faced with correcting the existing deficiencies found on these older highways, as well as restoring rideability and extending their service life.

In more recent years, pavements beyond their service life have shown signs of distress caused by unpredicted volumes of traffic and unanticipated wheel loadings. Heavy concentrations of deicing salts and lack of remedial maintenance have also contributed to these pavements rapid deterioration. One frequently occurring form of pavement distress being accelerated by the combination of these factors is joint faulting. Joint faulting is associated with concrete pavement originally constructed using two piece malleable iron load transfer devices. The joint faulting problem has reduced the service life and rideability of many Portland cement concrete pavements in New York State.

JOINT FAULTING

Joint faulting is the differential vertical displacement of abutting slabs at joints and/or cracks creating a step deformation in the pavement surface. As wheel loads move across a transverse joint, the loads must be transferred from one pavement slab to the next. When the two piece malleable iron load transfer devices supporting both slabs corrode and fail, the structural integrity of the joint is lost. The leave slab settles in reference to the approach slab, creating a step or "fault" in the pavement profile (Figure 1).

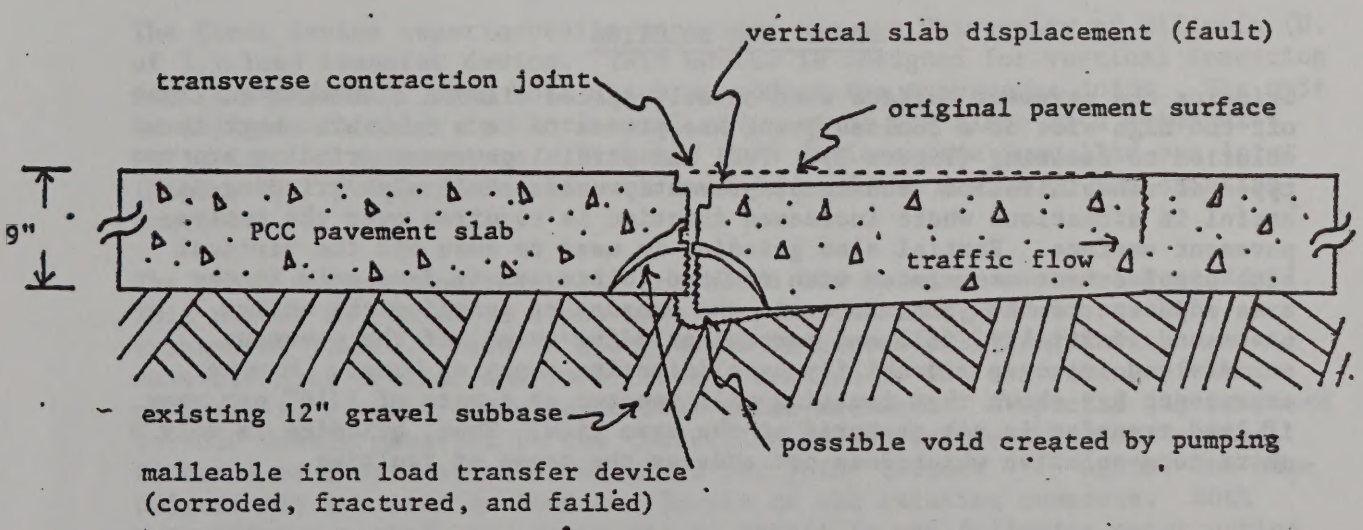

Figure 1 - Joint Faulting

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The cause of joint faulting is loss of proper joint support (failure of load transfer device) across the transverse joint. Unfortunately faulting is not simply explained. Rather, the interaction of several situations initiates faulting. The following are usually prerequisites:

1. High truck traffic volumes.

2. High truck axle loads.

3. Lack of properly sealed transverse joints allowing water and corrosive deicing salts in the joint.

4. Water in the area below an improperly sealed pavement joint weakens the subbase and promotes pumping of subgrade fines up through the joint. Pumping creates voids under the pavement allowing room for slab settlement.

5. Deicing salts entering the unsealed joint corrode the iron of the load transfer device in time.

6. During the normal pavement slab expansion and contraction, metal loss occurs as the iron pieces wear against one another.

7. Incompressibles in an unsealed joint causes a widening of the joint until the ends of the load transfer device are no longer in contact (Figure 1).

NOTE: This contract (D250399) also included subsealing some concrete slabs at faulted transverse joints. Installation of edge drains was also a feature of this project. The performance of these items will be evaluated and reported on in a separate publication.

SHORT TERM SOLUTION

Grinding the pavement surface with closely spaced diamond sawblades to taper off the high side of a faulted joint has proven to be a feasible short term solution to faulting (Figure 2). Full and partial pavement grinding are two types of rehabilitation techniques presently used. Full slab grinding is useful in situations where increased friction is required over the entire pavement surface. Partial slab grinding is used to even off the vertical slab displacement associated with faulted joints and is done only in the area adjacent to the joint to avoid the expense of grinding the entire pavement. Initially, full and partial grinding evens off the pavement surface and improves rideability by eliminating annoying bumps. However, experience has shown that faulting will reoccur at a rate of 1/16" per year if load transfer is not restored at the same time. Thus, grinding is only a short term solution which does not address the cause of faulting.

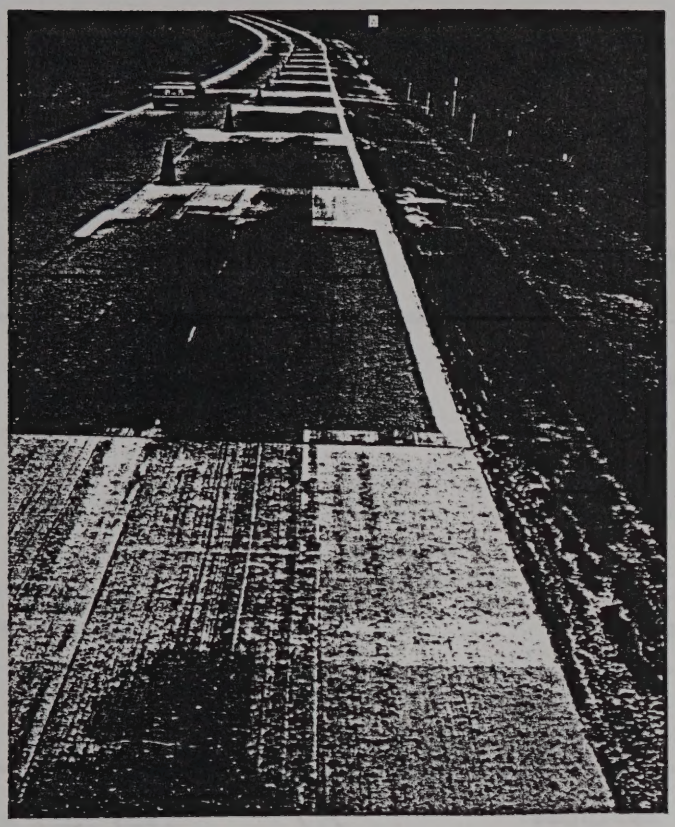


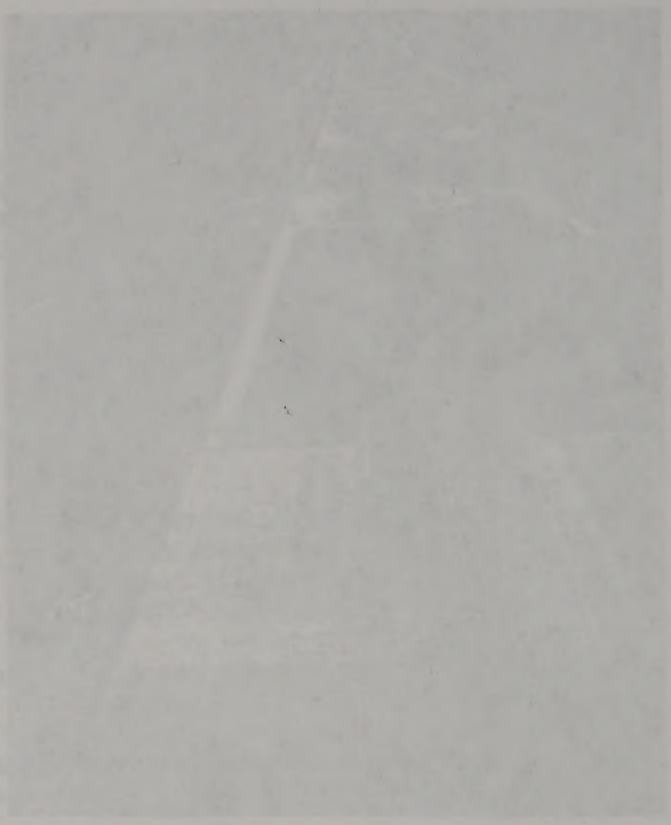
Figure 2 - Partial Grinding of Faulted Transverse Joints

LONG TERM SOLUTION

In an attempt to reestablish load transfer at transverse joints and thus prevent faulting from reoccuring after grinding, two types of devices have been installed and are currently being evaluated. Both were installed during 1983 in 130 of the 629 joints of a 3.6 mile contract on Interstate 84 near Ludingtonville. All the "retrofitted" joints were located in the 12 ft. wide driving lane of this four lane divided highway.

The first device experimentally installed was the University of Illinois (U. of I.) load transfer device. This device is designed for vertical insertion into a standard 6" core hole which straddles the transverse joint. The unit is designed to allow for horizontal movement of the slabs with seasonal variations of temperature. Either 3 or 4 devices were installed per joint (Figure 3). Polymer concrete was used to bond the device to the existing concrete.

The other device experimentally installed was an epoxy coated I beam dowel. This device is placed in slots sawn perpendicular to and across the transverse joints. Each 18" long dowel is coated full length with a suitable bond breaker and is oriented parallel to the centerline of the pavement to ensure future horizontal joint movement. A special jig was used to hold dowels parallel to the centerline as polymer concrete was placed. Either 4 or 8 devices were installed per joint (Figure 3). Again, the same polymer mix was used to bond the dowels to the existing concrete. Both retrofitting methods are described in detail in the following construction sequences and in the specifications in Appendix B. Both types are installed while traffic is being maintained in adjacent lanes. Traffic was rerouted over the installed devices after the polymer was cured for two hours.



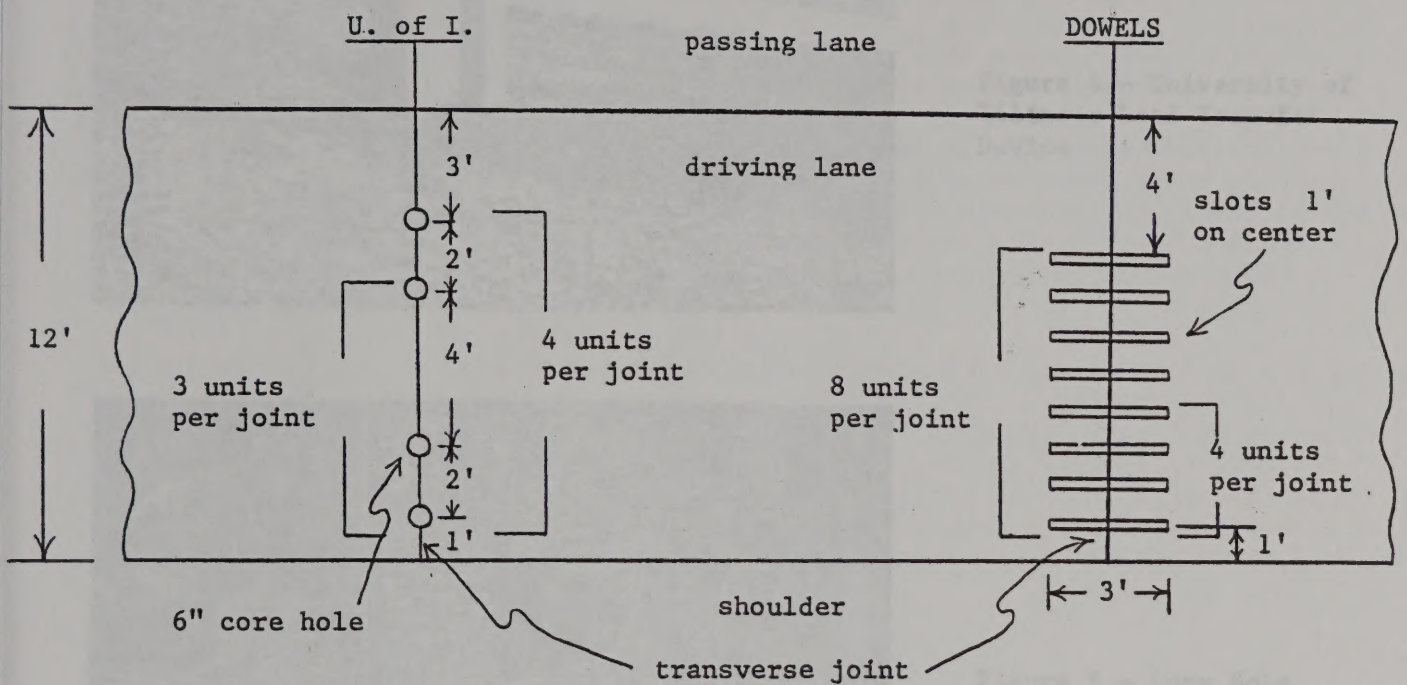


Figure 3 - Spacing of Load Transfer Devices

CONSTRUCTION SEQUENCE - UNIVERSITY OF ILLINOIS LOAD TRANSFER DEVICE

The following construction sequence was used to install the University of Illinois load transfer device after grinding had been completed.

An epoxy coated and a stainless steel University of Illinois load transfer device were both installed on this experimental project.

To install the U. of I. device (Figure 4), a core hole is established for each unit. A coring rig is used to drill six inch diameter holes, each hole being centered across the transverse joint (Figure 5). Three or four core holes were cut for each joint to be retrofitted. The core holes were spaced as shown in Figure 3. This spacing was used to support the wheel loads and to avoid the existing load transfer devices. The orientation of the device in the core hole is shown in Figure 6. The core hole walls are prepared for application of polymer primer and concrete after the concrete cores are removed.

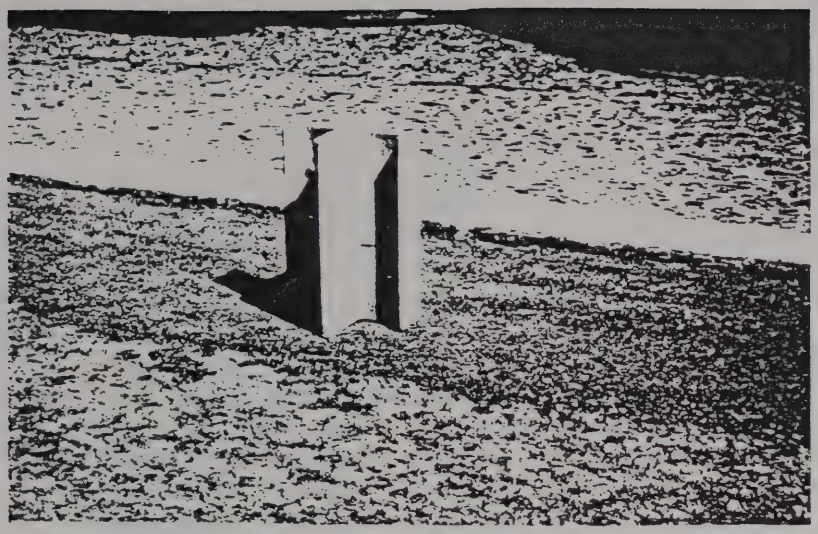


Figure 4 - University of Illinois Load Transfer Device

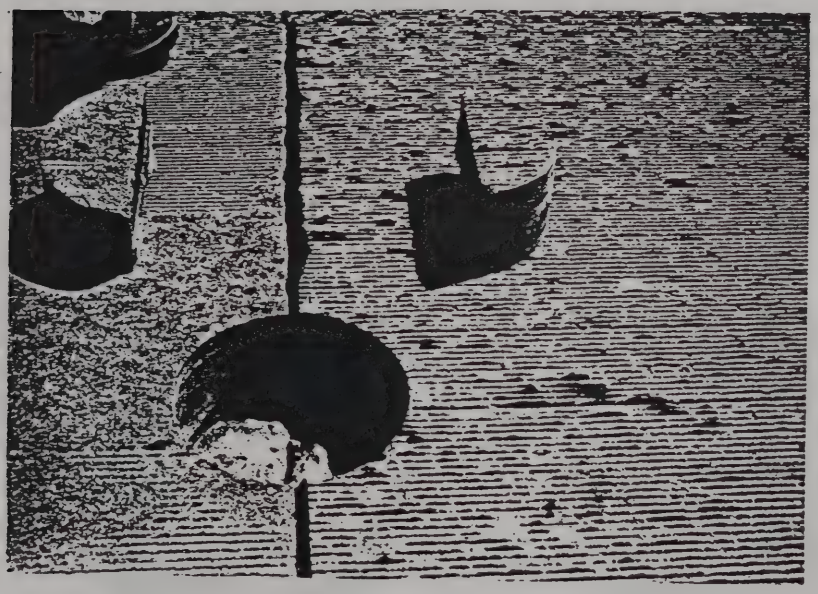


Figure 5 - Core Hole Centered On Transverse Joints

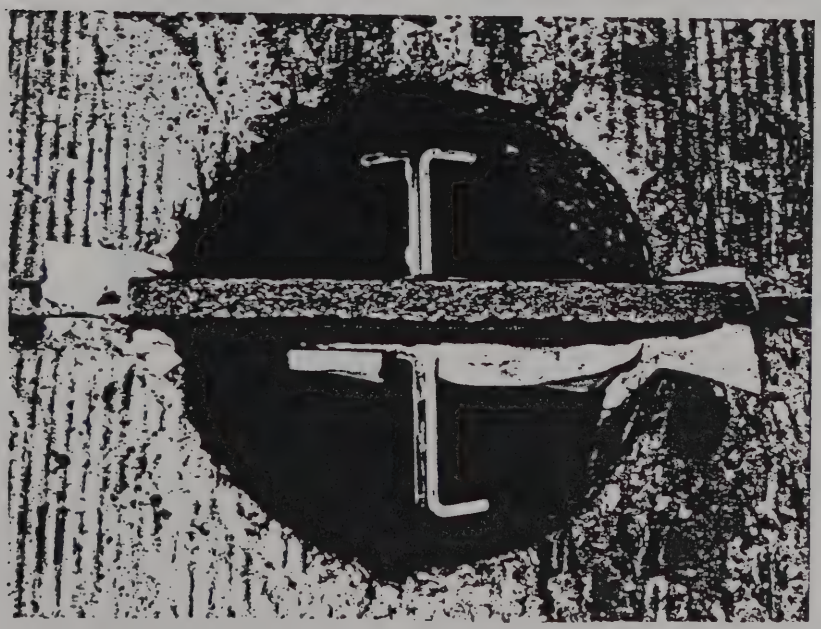


Figure 6 - U. of I. Orientation In Core Hole

The depth of each hole had to be adjusted because the University of Illinois device should be positioned 1 1/2" below the pavement surface. This clearance was required to avoid damaging the installed load transfer device when sawcutting a reservoir for joint sealant. A bar was used to loosen the well consolidated subbase to establish proper hole depth. When doing this, care was taken not to contaminate the core hole wall with subbase material.

Once proper hole depth was achieved, core hole walls were sandblasted to provide a better bonding surface (Figure 7). A round steel plate slightly smaller than the core hole was attached to a threaded rod and placed in the bottom of the hole to protect the subbase during sandblasting. When the sandblasting was completed, the plate was removed and any excess material vacuumed from the hole.

Masking tape was placed over contraction cracks in the hole wall to prevent polymer concrete from bonding adjacent slabs together. A plastic disk was then inserted in the bottom of the hole before priming. This disk prevents the primer and liquid portion of the polymer concrete from being absorbed into the subbase. A two component primer supplied by the polymer concrete manufacturer was brushed on the wall surface (Figure 8), the intent being to enhance the bond between the polymer concrete and the existing concrete.

Figure 7 - Sandblasting Core Hole Walls

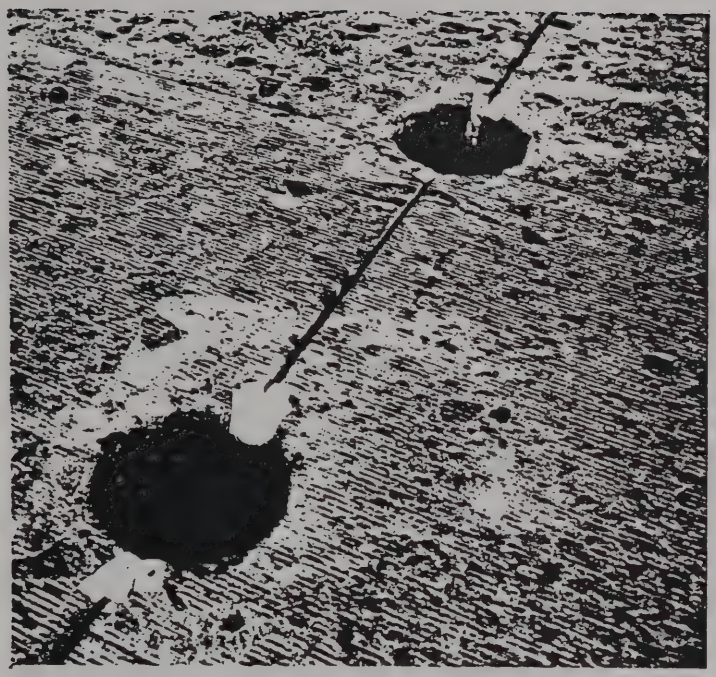


Figure 8 - Masking Tape Sealing The Crack, And Primer Applied To Core Hole Walls

Completing the construction sequence involved mixing and placing the polymer concrete. Once the load transfer device was installed in the hole, care was taken not to disturb its orientation. The polymer concrete was mixed in a plastic bag to the following proportions: One 30 pound bag of polymer powder, 57.5 oz. of polymer liquid and 20 pounds of 3/8 inch crushed gravel. The polymer mix was poured directly from the bag into the core hole. Two lifts, each requiring consolidation by rodding, were used to fill the hole. Fiberboard was wedged into the transverse joint above the installed device to act as a filler and establish a reservoir above the device (Figure 9). The polymer concrete reached its final set in approximately a half hour and the pavement was opened to traffic in approximately 2 hours.

The final operation was to sawcut along the repaired transverse joint to remove the fiberboard bond breaker and to provide a reservoir in the transverse joint for application of joint sealant (Figure 10).

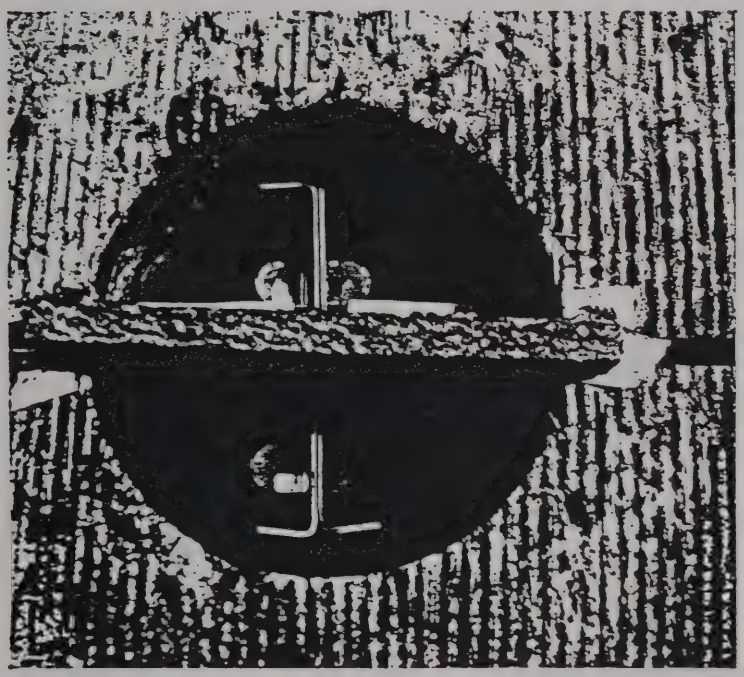


Figure 9 - Fiberboard Used As Bond Breaker Over A Stainless Steel U. of I. Device

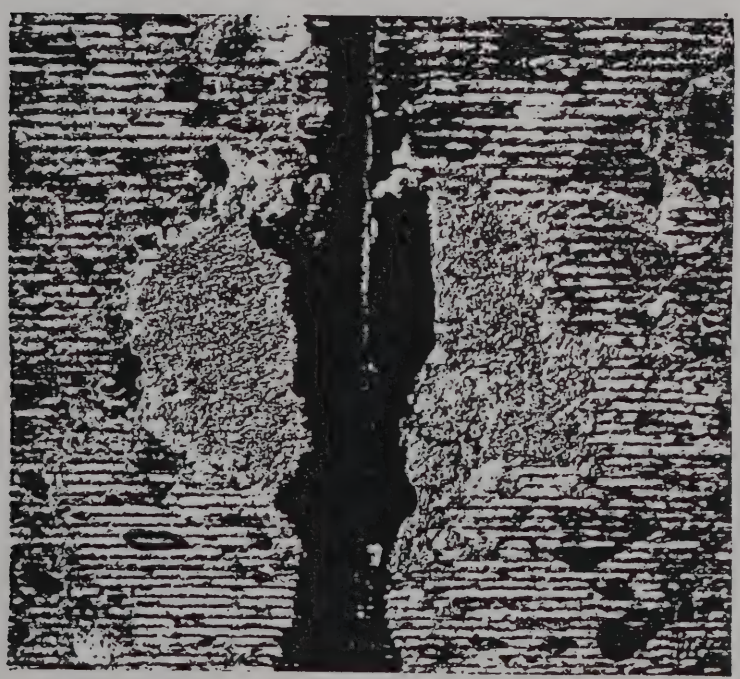


Figure 10 - Liquid Sealant Applied To Joint Reservoir

CONSTRUCTION SEQUENCE - DOWEL LOAD TRANSFER DEVICE

The following construction sequence is used to install the dowel load transfer devices. After grinding, slots for dowels were established by sawcutting grooves perpendicular to the transverse joint (Figure 11). The concrete pavement was removed from between the grooves using a chipping hammer to form the slots. Four or eight slots were created per transverse joint.

Dowel slots were prepared in the same manner as core holes for the U. of I. installation. Masking tape was used to seal the contraction crack at the transverse joint. The tape prohibits polymer concrete from flowing into the joint and bonding adjacent slabs together. Foam backer rod was used as a bond breaker to cover the contraction crack in the bottom of the slot. After sandblasting, polymer primer was applied to the slot to improve the bond between the polymer concrete and existing pavement.

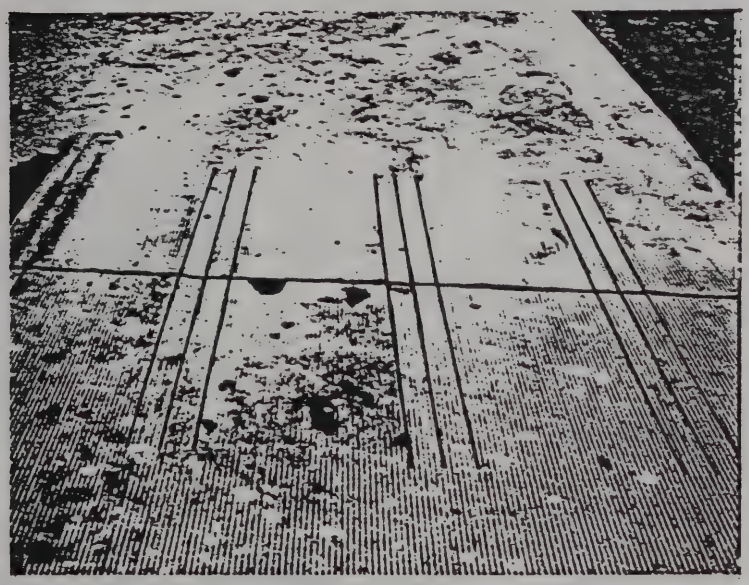


Figure 11 - Sawcut Grooves Used To Establish Slots, Pavement Is Removed From Between Grooves To Form Slots For Dowels

In order for the transverse joint to function properly during an expansion and contraction cycle, each dowel must be parallel to the centerline of the pavement. Skewed dowels lock up a transverse joint and cause stresses to develop in the pavement slabs. Therefore, it is critical dowels have the proper orientation. A fiberboard separator is placed mid way on the dowel to separate the polymer concrete on either side of the joint. To ensure correct orientation, a special dowel holding jig was manufactured by the Contractor and was used as the initial placement of polymer concrete cures. (Figure 12). Prior to installation, elastic straps held the dowels securely to the jig (Figure 13). Care was taken to align each jig parallel with the centerline of the pavement (Figure 14).

Polymer concrete was placed in two lifts. The first lift, in the bottom-center of the slot, allows the polymer to cure and bond the dowels in place without bonding the supporting jig in the slots. Once the first lift cures, the end straps and supportive jig were removed, leaving all dowels aligned properly in their slots (Figure 15). The second lift fills the void remaining in the slots. This polymer concrete was consolidated and finished by hand troweling (Figure 16).

Figure 12 - Special Jig Used To Hold Dowels At Proper Depth & Orientation

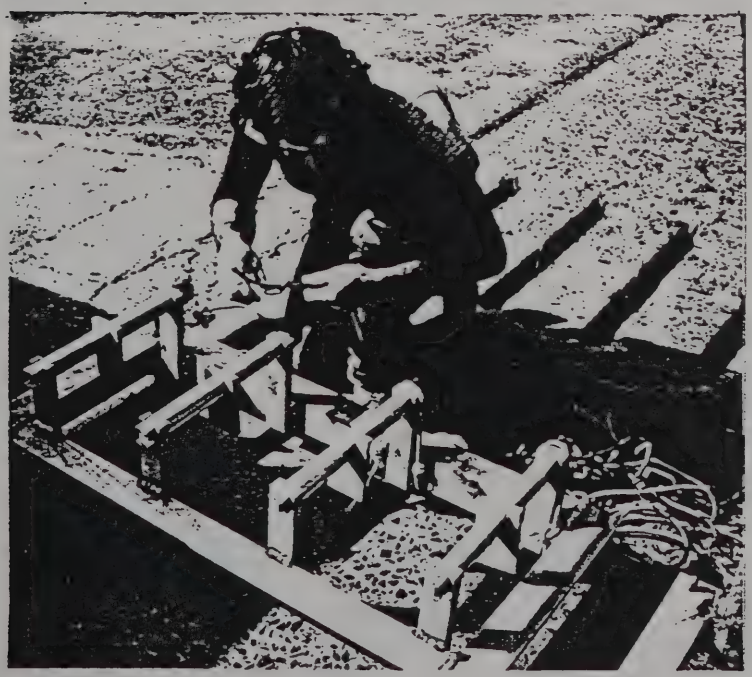


Figure 13 - Elastic Straps Used To Hold Dowels On Jig

Figure 14 - Jig and Dowels Aligned Parallel To Centerline Of Highway

Figure 15 - Cured Polymer Concrete In Middle Of Slot After Jig Is Removed

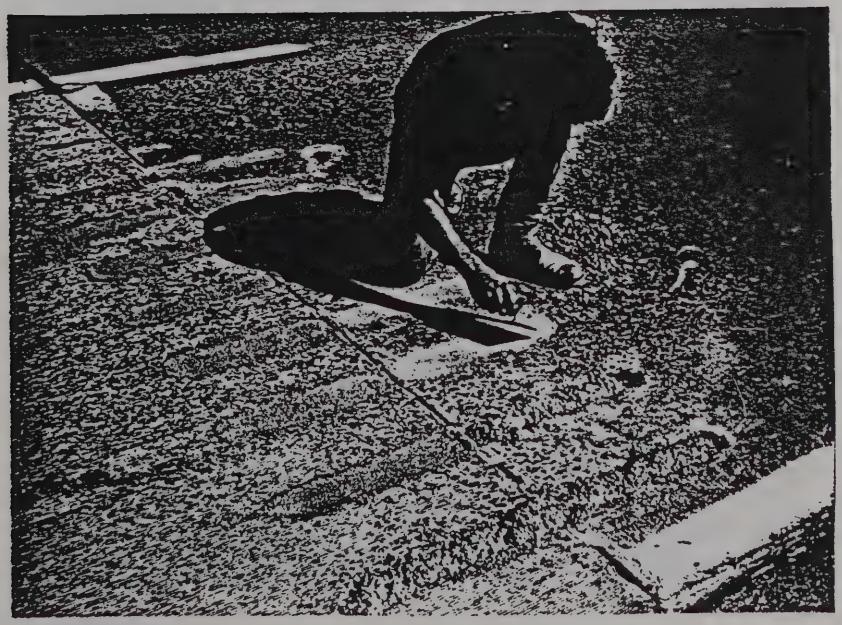


Figure 16 - Final Hand Troweling Of Dowel Slots

Completing the dowel installation involves sawcutting a reservoir for joint sealant through the fiberboard which separates the cured polymer concrete.

INVESTIGATIONS

Load Transfer Device Type	Devices Per Joint	Number of Joints	Total Number Installed
University of Illinois	3	20	60
	4	58	232
Dowel	4	20	80
	8	32	256

Contract D250399

Listed above are the combinations of load transfer devices installed per joint. A total of 292 University of Illinois units were placed in 78 transverse joints. By April, 1984, 46 U. of I. devices had failed. These failures are characterized by a semicircular crack at the interface of the polymer concrete and the existing pavement slab (Figure 17). Construction records indicate 30 of the 46 U. of I. devices that failed were installed on the first two days of placement and failures only occurred on all but one of the joints containing four devices.

A total of 336 dowel load transfer devices were installed in 52 joints. By April, 1984, none of the dowels had failed.

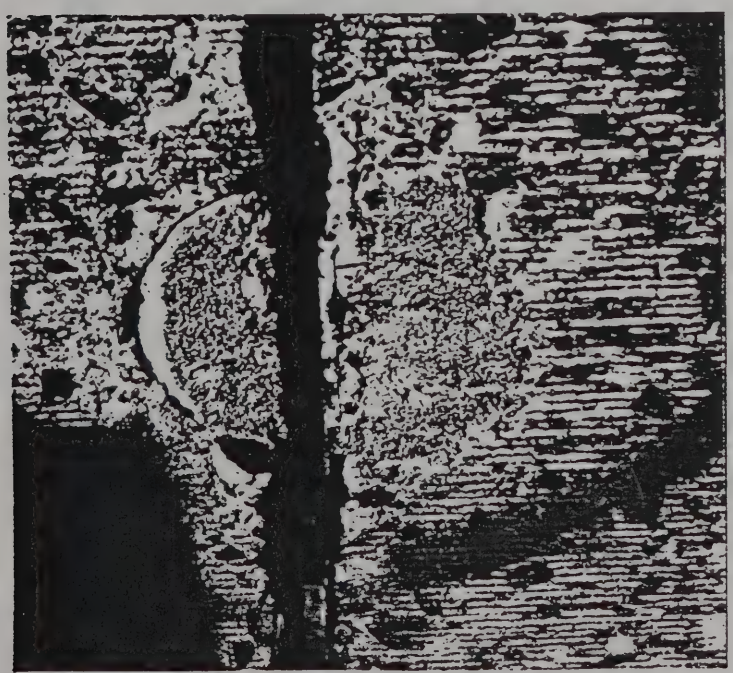


Figure 17 - U. of I. Failure Indicated By Semi-Circular Crack To The Left Of The Joint

Comparison of bid prices for installed devices shows the dowel method to be more expensive per joint than the University of Illinois method. However, the dowel method has performed better to date than the U. of I. installation.

In response to the University of Illinois device failures, cores were taken from the failed installations in an attempt to determine the cause. Several observations were noted from these cores. Honeycombing of the polymer concrete was evident. The polymer primer did not appear to be absorbed by the existing concrete, and was easily flaked off the core hole wall surface. The cores also revealed a large void between the flange of the device and the core hole wall (Figure 18). A 1/4" space between the flange and the core hole wall was specified as a minimum with a 6" core hole (Figure 6). The aggregate used to extend the mix (type one stone), was 3/8" size. Possibly the consistency of the polymer concrete was too dry, and some of the 3/8" stone blocked the 1/4" opening, preventing the stiff mix from flowing behind the flange.

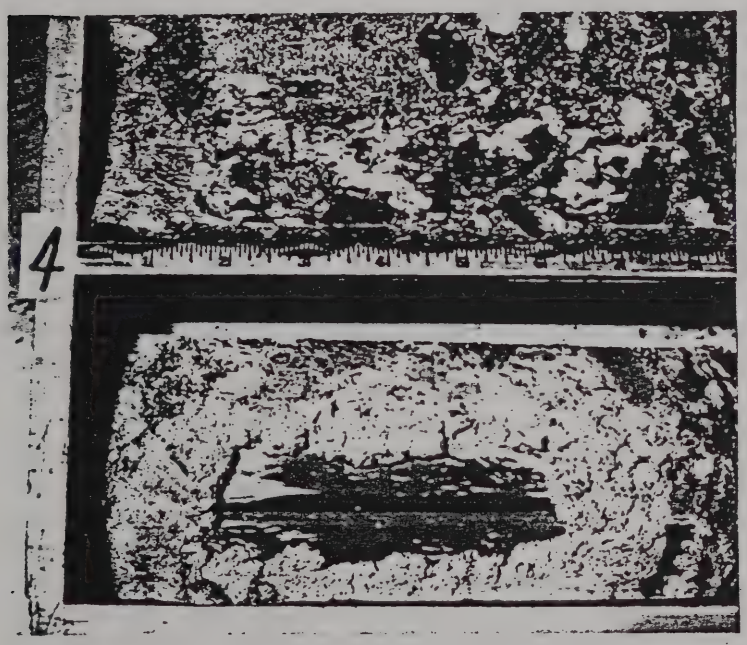


Figure 18 - Large Void Between Flange Of U. Of I. Device And Core Hole Wall

To address the polymer primer problem, a direct shear experiment was conducted to determine if the primer was developing sufficient bond to the existing concrete. Samples for the direct shear test were prepared by bonding polymer concrete to original pavement cores with a polymer primer interface. Perhaps moisture in the core hole decreased the primers bonding capabilities. Results of the direct shear tests showed that the oven dried pavement samples bonded to polymer concrete with a primer interface had higher shear strengths than saturated surface dry samples prepared in a similiar fashion. The results of the direct shear test are in the following listing.

Shear Test Results

Sample	Primer	No Primer
Saturated Surface Dry Pavement Core	500, 520 psi	520 psi
Oven Dried Pavement	607, 639 psi	880 psi[1]

1) Problems during shear testing of this sample, value may be erroneous.

It's normal that a certain amount of moisture will be absorbed from the atmosphere by the concrete walls of the core holes. This situation is simulated by the saturated surface dry shear test samples. The above results show that the polymer primer bonds better to a dry concrete surface than to one that is saturated surface dry. To improve the polymer primer's bonding abilities, it is recommended that core holes and slots be investigated for the presence of moisture prior to primer application. If moisture is present, the holes or slots should be dried with a heating device and allowed to cool before polymer primer is applied. A soft paint brush, which is changed frequently, is recommended for application of the polymer primer.

University of Illinois load transfer device failures appear to be caused from a combination of unrelated factors. The fact that only one failure occurred in joints using 3 U. of I.'s per joint and the remaining failures occurred in joints using 4 devices per joint indicates this problem is not load related. Transverse joints incorporating 4 devices should be stronger, but since the majority of failures occurred in this situation, it indicates the problem is construction related. Since this is an experimental construction technique, a certain amount of trial and error is involved. The fact that most of the U. of I. devices that failed were installed during the first two days of load transfer device placement confirms this. Poorly consolidated polymer concrete was associated with many failures. The honeycombing and voids that accompany non-consolidated polymer concrete results in less polymer surface area in contact with the bonding surface of the pavement slab. This develops stresses, in the areas that have bonded, which are higher than anticipated. Along with this, the polymer primer doesn't appear to be absorbed by the existing concrete. In cored failures, the primer was easily removed from the original pavement slab with a knife. It is felt that the combination of inexperience, poor polymer concrete consolidation, and insufficient polymer primer bonding has contributed to the majority of the U. of I. failures.

CONCLUSIONS

1) Load transfer devices can be installed while maintaining traffic in adjacent lanes. Traffic can be placed over the completed load transfer device installation after 2 hours.

2) Debonding failures of the U. of I. type devices are associated with primer bond failure and lack of consolidation of polymer concrete. 46 out of 292 U. of I. type devices have debonded during the first six months of service. No evidence of debonding of the dowel type device has been noted after ten months of service.

3) Investigation of the failures of the U. of I. device has shown that improving polymer concrete consolidation is necessary. Also, polymer primer should not be applied to a wet surface in the core holes or dowel slots.

4) Performance monitoring of the load transfer devices should be continued.

APPENDIX A

The installed bid prices for each device is listed below according to contract (includes polymer concrete):

Contract D250399 — Letting date - 04/28/83

			Quantity Installed
University of Illinois	-	$ 80.00 (each)	292
Dowel Bar	-	$100.00 (each)	336

Contract D250602 — Letting date - 06/23/83

			Proposed Quantity Installed
University of Illinois	-	$ 75.00 (each)	1000
Dowel Bar	-	$ 85.00 (each)	2000

APPENDIX B

NOTE: The specifications included are currently being revised to correct construction problems encountered on the first contract.

ITEM 18502.3402 - U of I RETROFIT LOAD TRANSFER DEVICES FOR TRANSVERSE JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

Under this item, the Contractor shall furnish and install new retrofit load transfer devices in accordance with this specification and at locations shown in the contract plans and/or as directed by the Engineer. This item shall also include coring 6" +1/8" diameter core holes into which the devices will be placed setting the devices in polymer concrete and forming transverse joint grooves to reestablish transverse joints over the devices.

MATERIALS

U of I Retrofit Load Transfer Devices - The devices furnished shall be the U of I type as manufactured by the Dayton Superior Corporation of Miamisburg, Ohio. The devices shall be produced from two pieces of #11 guage mild steel (type A36) which have been formed and resistance welded or rivited together to conform to the configuration and dimensions as detailed in the contract plans. After fabrication, the devices shall be completely coated with a minimum 7 mil film thickness of epoxy. The interior portion of the bellows of each device shall then be filled with polyurethane foam for its entire depth. Two precut pieces of 1/4" thick polyvinyl foam with adhesive backing shall be furnished with each device. Prior to installation the foam shall be applied over the exterior of the bellows of each device for its entire depth to act as an expansion medium, as a sealer between the core hole and ends of the steel bellows, and bond breaker between the device and abutting polymer concrete.

Polymer Concrete - The polymer concrete (P.C.) furnished shall be a two-component methyl methacrylate (MMA) polymer concrete system as manufactured by Transpo Materials, Inc. (Silikal), Dural Internation Corp. (Duracryl), Adhesive Engineering Co. (Concresive) and approved by the Director, Materials Bureau.

The powder component shall be pre-mixed material consisting of polymer, catalyst, fine fillers and fine aggregates not to exceed 1/16" in diameter. The MMA monomer liquid shall contain that amount of hardener required for curing of the system within 45 minutes to 2 hours under field conditions with substrate temperatures as low as 15°F.

The mortar mix prepared from the pre-packaged material shall be sufficiently plastic to accept additional completely dried graded aggregate, sized from 1/8" to 1/2".

The aggregate used to extend the yield shall meet requirements of Section 703-02 Coarse Aggregate except crushed slag shall not be allowed. The aggregate gradation and quantity shall be in accordance with the manufacturer's recommendations and approved by the Director, Materials Bureau based on laboratory trial mixes.

The pot life of the mixed mortar shall have a range of 8 to 15 minutes and the workability of the mortar shall be consistent throughout the substrate temperature range of 15°F to 100°F.

A primer shall be provided to coat the core hole walls prior to placing the polymer concrete. The primer shall be a two-component MMA resin based system with a curing time of 20 to 60 minutes.

All of the above specifications shall be applicable throughout a substrate temperature range of 15°F to 100°F, unless otherwise noted.

The Contractor shall submit a 30 lb. bag of the powder component, 1/2 gallon of monomer liquid and 50 lbs. of aggregate to the Director, Materials Bureau for trial mixes and approval. The Director shall be allowed 15 working days from the time he receives the samples to render his decision.

CONSTRUCTION DETAILS

The U of I retrofit load transfer devices shall be placed after the grinding operations are completed but before the transverse and longitudinal joints are resealed.

The Contractor shall core 6" +1/8" diameter holes directly through the transverse contraction joints for the full depth of the existing PCC pavement at the locations shown in the contract plans and/or as directed by the Engineer. Care shall be taken to insure that the core holes are plumb and that half the core is taken from one pavement slab and half from its adjoining counterpart, the widest portion of the core hole (6" dia.) being at the centerline of the existing transverse joint groove.

Immediately after coring the slurry residue remaining in the core hole shall be removed and the holes allowed to dry thoroughly before the core walls are sandblasted. If the pavement is opened to traffic after the coring but before sandblasting commences, the Contractor shall replace the cores in their respective holes to prevent foreign material from collecting in the holes between operations. Once the cores no longer serve a useful purpose they shall be removed from the project site or be disposed of within the R.O.W. at a location satisfactory to the Engineer.

The Contractor shall schedule his operations so that the core hole walls are sandblasted and vacuumed immediately before the installation of the retrofit load transfer devices. These operations shall not take place in wet weather.

The core hole walls shall be sandblasted for their full depth to remove any residue remaining from coring and to roughen the surface of the walls to increase bond strength. Immediately thereafter, the holes shall be vacuum cleaned. The Engineer shall approve all sandblasting and vacuum cleaning equipment prior to commencing operations. ~~Care shall be taken not to disturb the subbase in the bottom of the core holes during the sandblasting and vacuuming operations.~~ At the conclusion of these operations, the core hole walls shall be rough and dry as well as dirt, oil and dust free, as determined by the Engineer.

The core hole walls shall then be coated with a MMA based primer coat applied to the full depth of the concrete substrate with a brush. Precautions shall be taken to prevent the primer from penetrating the transverse joint grooves and contraction cracks below the grooves. The polymer concrete may be placed during the primer coat's cure period.

Before setting the retrofit load transfer devices into the primed core holes, the two pieces of 1/4" thick polyvinyl foam shall be applied to the exterior bellows portion of each device. The devices shall then be set on the subbase so that the bellows portion of the devices are aligned with the transverse joint grooves and the anchor portions are equidistant from the core hole walls. Extreme care shall also be taken to keep the devices properly aligned in both the horizontal and vertical plane while the polymer concrete is being placed around them. The devices shall be set 1 inch ±1/4 inch below the prepared ground concrete pavement surface. The subbase shall be excavated as necessary to accomplish the desired orientation.

The polymer concrete shall be mixed by utilizing the plastic bag supplied by the manufacturer or by suitable mechanical means recommended by the manufacturer and approved by the Engineer. The mortar shall be mixed with the quantity of pre-mixed powder components and supplied monomer liquid in the proportions specified by the manufacturer. Additional aggregate as described in the material specifications shall then be added.

The polymer concrete shall not be placed on a wet surface or when the concrete substrate is 15°F or less or 100°F or more.

The mixed polymer concrete shall be manually placed in the core holes as specified by the manufacturer. It shall be finished by troweling, screeding or by a suitable method recommended by the manufacturer and approved by the Engineer. The finished P.C. surface shall be the same elevation, cross slope and texture as the adjacent concrete.

Tape or approved sealers shall be used to prevent the polymer concrete from flowing into the gap between the ends of the bellows and transverse joint and bridging this area.

All the safety precautions recommended by the manufacturer for handling polymer concrete shall be strictly adhered to during mixing and placing operations.

The work shall progress in such a way that the polymer concrete is cured for a minimum of 2 hours before the roadway is scheduled to be opened to traffic.

Transverse joint grooves shall be reestablished over the retrofit load transfer devices by forming the groove while the polymer concrete is being placed.

The grooves shall be formed full depth from the surface to the top of the devices. The width of the formed grooves shall be within 1/16" of the existing transverse joint groove widths. The medium used to form the grooves must be rigid, water tight and treated with release agents recommended by the manufacturer of the devices and approved by the Engineer.

The joint grooves over the devices shall be cleaned and sealed at the same time, in the same manner and with the same material as is used to reseal the existing transverse joint grooves on the project.

If the contract plans require the Contractor to widen the existing transverse joint grooves on the project prior to cleaning and resealing, the reestablished joint grooves over the retrofit load transfer devices shall also be widened by sawing. Extreme care shall be taken not to strike the devices with the saw blade during the sawing operation.

BASIS OF ACCEPTANCE

The retrofit load transfer devices will be accepted at the project on the basis of certification by the manufacturer that the devices meet this specification's requirements.

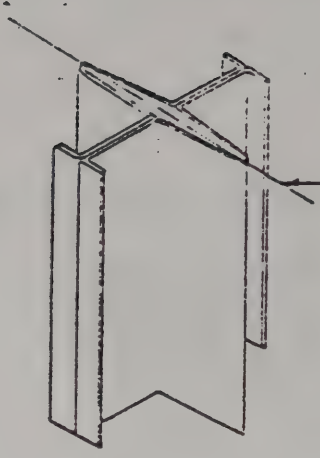
The polymer concrete and primer will be accepted at the project on the basis of certification by the manufacturer that the materials meet this specification's requirements.

METHOD OF MEASUREMENT

The quantity to be paid for under this item will be the number (each) of retrofit load transfer devices incorporated into the completed work in accordance with the contract plans and/or as directed by the Engineer.

BASIS OF PAYMENT

The unit price bid per each shall include the cost of furnishing all labor, equipment and material necessary to core the six inch diameter holes, clean and sandblast the holes, set the devices in polymer concrete and form the transverse joint grooves over the devices as specified herein. Cleaning and sealing joint grooves over the retrofit load transfer devices will be paid for separately under its appropriate item.



ITEM ___ UofI RETROFIT LOAD TRANSFER DEVIC
FOR TRANSVERSE JOINTS IN PORTLAN
CEMENT CONCRETE PAVEMENT

6" ± 1/8" DIA.
CORE HOLE

#11 GAUGE
MILD STEEL
(TYPE A36)

℄ OF TRANS. JT.

1/4" MIN. 1/2" MAX.

5 1/4" ± 1/4"

3/8"

1/4" DIA. HOLE
1/8" FROM TOP SURFACE

HOLES MUST BE AT
SAME END FOR
PRODUCTION

1/4" POLYVINYL FOAM

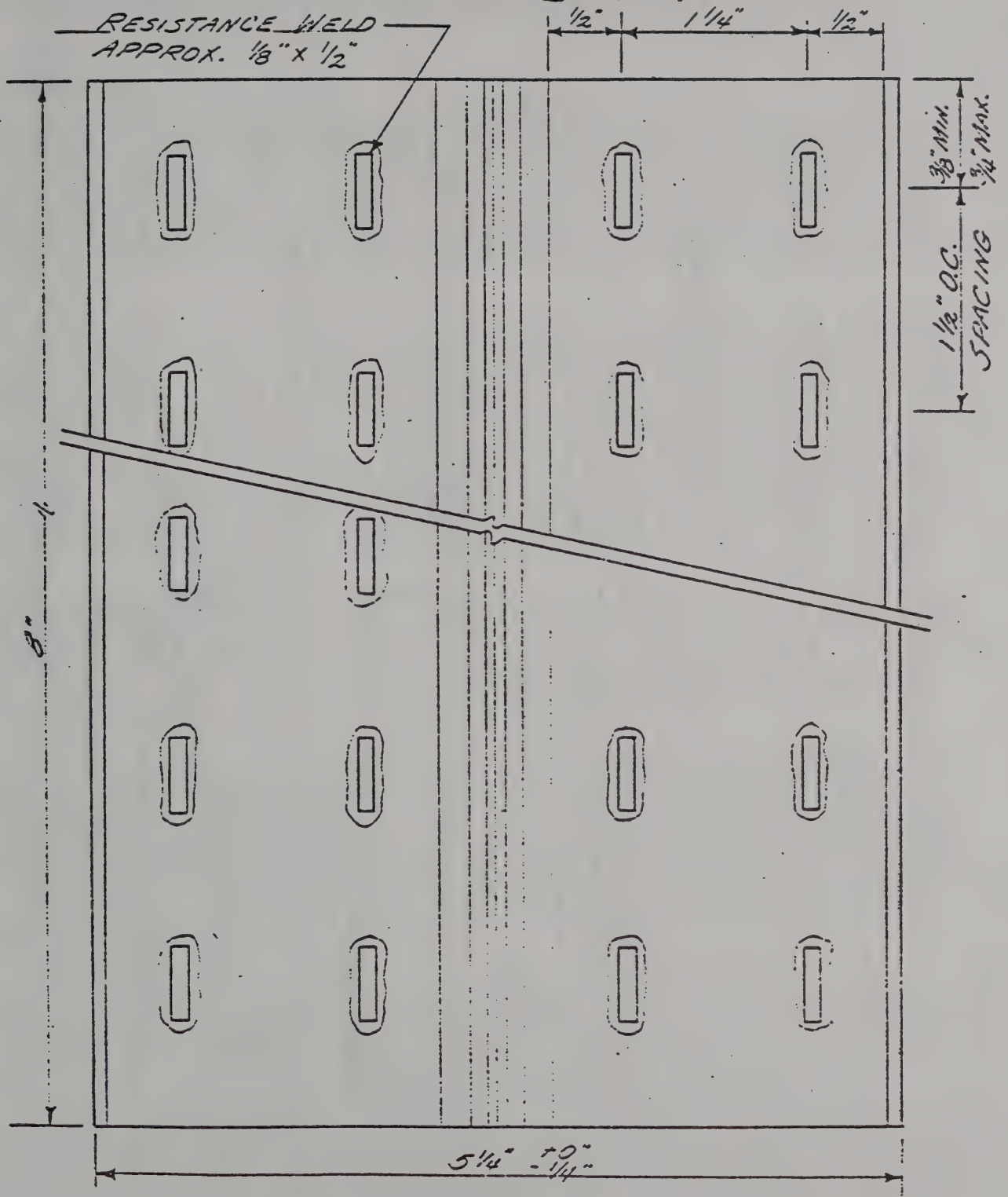
3/4" 3/4"

1/4" CLEARANCE

5 1/2" ± 1/8"

TOP VIEW
NO SCALE

ITEM — U OF I RETROFIT LOAD TRANSFER DEVICES FOR TRANSVERSE JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT



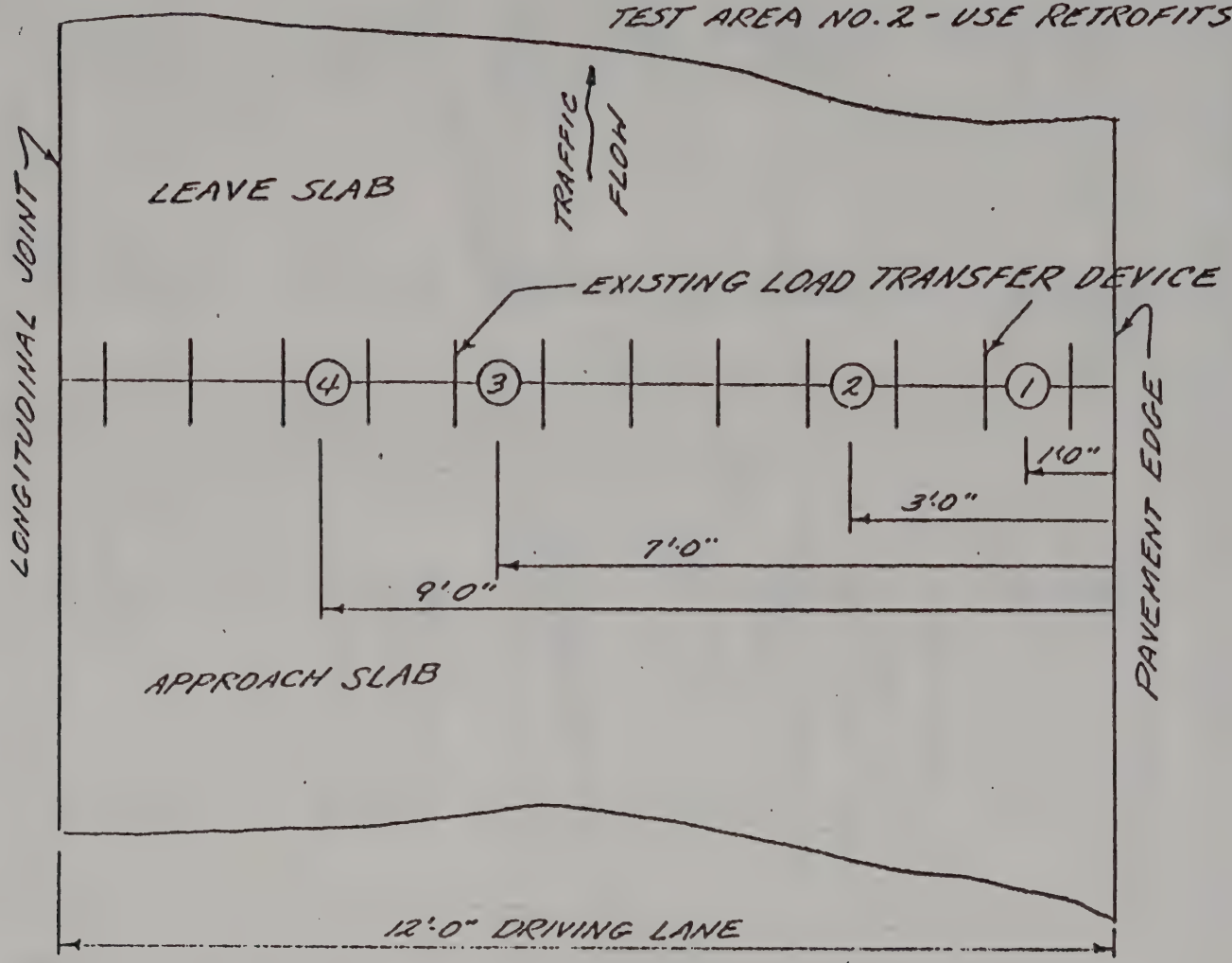
SIDE VIEW

NO SCALE

LOCATION OF CORE HOLES FOR U OF I RETROFIT LOAD TRANSFER DEVICES

TEST AREA NO. 1 - USE RETROFITS AT ① ② ③

TEST AREA NO. 2 - USE RETROFITS AT ① ② ③ ④



NO SCALE

ITEM 18502.3401 DOWEL RETROFIT LOAD TRANSFER DEVICES FOR TRANSVERSE JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

Under this item, the Contractor shall furnish and install new dowel retrofit load transfer devices in accordance with this specification and at locations shown in the contract plans and/or as directed by the Engineer. This item shall also include sawing channels into which the devices will be placed, cleaning and sandblasting these channels, firmly aligning the devices in polymer concrete and forming transverse joint grooves to reestablish transverse joints over the devices.

MATERIALS

Dowel Retrofit Load Transfer Devices - The dowel element of the devices furnished shall be either the same round dowels described in subsection 705-15 Transverse Joint Supports or the I beam type as shown on Standard Sheet 502-9. The dowels chosen shall be coated with a 12-15 mil dry film thickness of Scotchkote 213, an 8^{+12}_{-3} mil dry film thickness of Harcote, a 12-15 mil dry film thickness of Hysol DK 23-0679 or any other fusion bonded powdered epoxy coating approved by the Director, Materials Bureau. In addition, each dowel shall be coated with a suitable bond breaker which shall be compatible with polymer concrete and shall be subject to the approval of the Director, Materials Bureau.

Each retrofit device shall be comprised of one of the above described dowels, a matching expansion cap, a dowel supporting joint forming medium and at least one other dowel supporting device or chair. Additional dowel supporting devices or chairs will be allowed if needed to support the dowels while the polymer concrete is curing. Generally, the retrofit devices should conform to the configurations and dimensions shown in the contract plans.

Before fabrication, the Contractor shall submit detailed shop drawings showing how the dowel supporting device(s) or chair(s) and the dowel supporting joint forming medium will be attached to the dowel. The drawings shall also include descriptions of the materials that the supplier proposes to use for the dowel supporting device(s) or chair(s) and the dowel supporting joint forming medium. These drawings shall be submitted to the Director, Materials Bureau for approval. A decision will be rendered in five working days from the time the drawings are received.

Polymer Concrete - The polymer concrete (P.C.) furnished shall be a two component methyl methacrylate (MMA) polymer concrete system as manufactured by Transpo Materials, Inc. (Silikal), [illegible], Dural International Corp. (Duracryl), Adhesive Engineering Co. (Concresive) or approved by the Director, Materials Bureau.

The powder component shall be a pre-mixed material consisting of polymer, catalyst, fine fillers and fine aggregates not to exceed 1/16" in diameter. The MMA monomer liquid shall contain that amount of hardener required for curing of the system within 45 minutes to 2 hours under field conditions with substrate temperatures as low as 15°F.

The mortar mix prepared from the pre-packaged material shall be sufficiently plastic to accept additional completely dried graded aggregate, sized from 1/8" to 1/2".

The aggregate used to extend the yield shall meet requirements of Section 703-02 Coarse Aggregate except crushed slag will not be allowed. The aggregate gradation and quantity shall be in accordance with the manufacturer's recommendations and approved by the Director, Materials Bureau based on laboratory trial mixes.

The pot life of the mixed mortar shall have a range of 8 to 15 minutes and the workability of the mortar shall be consistent throughout the substrate temperature range of 15°F to 100°F.

A primer shall be provided to coat the channel walls prior to placing the polymer concrete. The primer shall be a two-component MMA resin based system with a curing time of 20 to 60 minutes.

All of the above specifications shall be applicable throughout a substrate temperature range of 15°F to 100°F, unless otherwise noted.

The Contractor shall submit a 30 lb. bag of the powder component, 1/2 gallon of monomer liquid and 50 lbs. aggregate to the Director, Materials Bureau for trial mixes and approval. The Director shall be allowed 15 working days from the time he receives the samples to render his decision.

CONSTRUCTION DETAILS

The dowel retrofit load transfer devices shall be placed after the grinding operations are completed but before the transverse and longitudinal joints are resealed.

The Contractor shall saw three inch wide (minimum) channels of sufficient length and depth to accommodate the retrofit load transfer devices as detailed in the contract plans at the locations shown in the contract plans and/or as directed by the Engineer. Care shall be taken to insure that the channels are perpendicular to the existing transverse joint grooves and parallel with each other, with half the channel being in one pavement slab and the other half in its adjoining counterpart. The method used to saw the channels shall be determined by the Contractor subject to the approval of the Engineer.

Immediately after sawing all chips of concrete and slurry residue remaining in the channels shall be removed to the satisfaction of the Engineer. The channels shall then be allowed to dry thoroughly before sandblasting commences.

The Contractor shall schedule his operations so that the channels are sandblasted and vacuumed immediately before the installation of the retrofit load transfer devices. These operations shall not take place in wet weather. The channels shall be sandblasted for their full depth to remove any residue remaining from chipping and sawing and to roughen the surface of the channels to increase bond strength. Immediately thereafter the channels shall be vacuum cleaned. The Engineer shall approve all sandblasting and vacuum cleaning equipment prior to commencing operations. At the conclusion of these operations the channels shall be rough and dry as well as dirt, oil and dust free as determined by the Engineer.

The channels shall then be coated with a MMA based primer coat applied to the full depth of the concrete substrate with a brush. Precautions shall be taken to prevent the primer from penetrating the transverse joint grooves and contraction cracks below the grooves. The polymer concrete may be placed during the primer coat's cure period.

The polymer concrete shall be mixed by utilizing the plastic bag supplied by the manufacturer or by suitable mechanical means recommended by the manufacturer and approved by the Engineer. The mortar shall be mixed with the quantity of pre-mixed powder components and supplied monomer liquid in the proportions specified by the manufacturer. Additional aggregate as described in the material specifications shall then be added.

The polymer concrete shall not be placed on a wet surface or when the concrete substrate is 15°F or less or 100°F or more.

The mixed polymer concrete shall be manually placed in the channels in two lifts. The initial placement shall consist of just enough polymer concrete to support the ends of each dowel. The dowel shall then be placed in the fluid polymer concrete and oriented within 1/8 inch per foot in both the horizontal and vertical directions. Also, the mid-point of the dowel shall be within one inch of the transverse joint groove. The polymer concrete shall partially encase the ends of the dowel once the dowel is properly oriented. Orientation of the dowel shall be accomplished while the polymer concrete is still in a fluid state. After the initial placement of polymer concrete has reached its initial set, and the dowel is firmly bonded in place, the second lift shall be placed filling the remainder of the channel. This lift shall be finished by troweling, screeding, or by a suitable method recommended by the manufacturer and approved by the Engineer. The finished P.C. surface shall be the same elevation, cross-slope and texture as the adjacent concrete. If the Contractor can demonstrate to the satisfaction of the Engineer that the dowels can be placed and anchored in their proper orientation by means other than that described in this specification, he will be allowed to do so.

Tape or approved sealers shall be used with the dowel devices to prevent the polymer concrete from flowing into the gap between the transverse joint former and transverse joint and bridging this area.

All the safety precautions recommended by the manufacturer for handling polymer concrete shall be strictly adhered to during mixing and placing operations.

The work shall progress in such a way that the polymer concrete is cured for a minimum of 2 hours before the roadway is scheduled to be opened to traffic.

Transverse expansion joints shall be established by forming the joint while the polymer concrete is being placed.

The width of the joint shall be within 1/16" of the existing transverse joint groove widths. The medium used to form the joint must be rigid, compressible, water tight and treated with release agents recommended by the manufacturer of the polymer concrete and approved by the Engineer.

The expansion joints formed shall be full depth from the surface of the pavement to the subbase. Immediately before cleaning and sealing only the top inch of the former shall be removed.

The joint grooves remaining after the top inch of the formers are removed shall be cleaned and sealed at the same time, in the same manner and with the same material as is used to reseal the existing transverse joint grooves on the project.

If the contract plans require the Contractor to widen the existing transverse joint grooves on the project prior to cleaning and resealing, the reestablished joint grooves over the retrofit load transfer devices shall also be widened by sawing.

BASIS OF ACCEPTANCE

The retrofit load transfer devices will be accepted at the project on the basis of certification by the manufacturer that the devices were manufactured in accordance with the approved shop drawings and this specification. The manufacturer's certification shall also include the following:.

1. The name of the bond breaker and name and address of the manufacturer.
2. The type of coating and name and address of the manufacturer.
3. The name and address of the coating applicator.
4. The ASTM grade of steel and rolling mill.
5. The name and address of the assembly manufacturer.
6. The correlation between the rolling mill's and supplier's certifications.

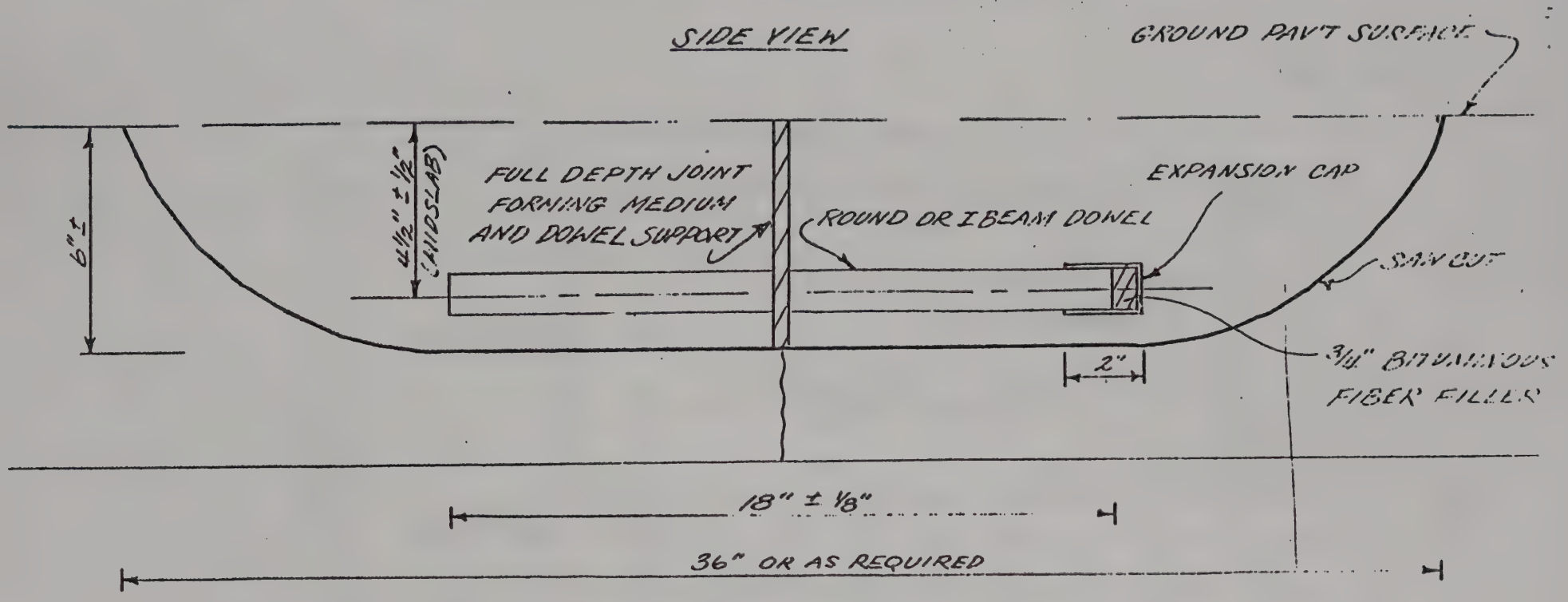
METHOD OF MEASUREMENT

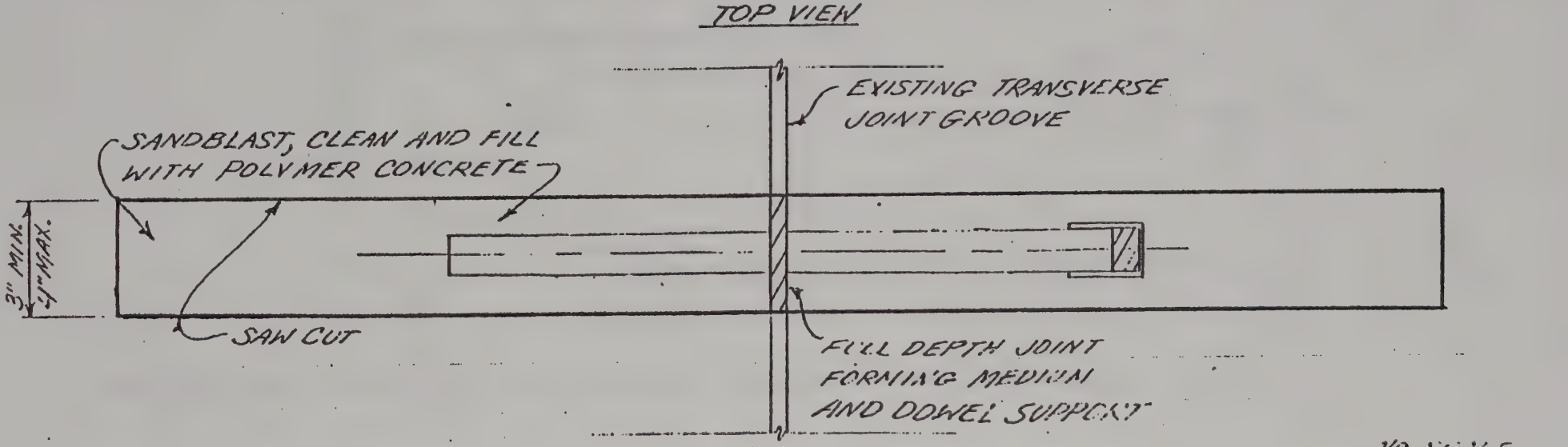
The quantity to be paid for under this item will be the number (each) of retrofit load transfer devices incorporated into the completed work in accordance with the contract plans and/or as directed by the Engineer.

BASIS OF PAYMENT

The unit price bid per each shall include the cost of furnishing all labor, equipment and material necessary to construct the required channels, clean and sandblast the channels, set the devices in polymer concrete and form the transverse expansion joints as specified herein. Cleaning and sealing joint grooves over the retrofit load transfer devices will be paid for separately under its appropriate item.

JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT



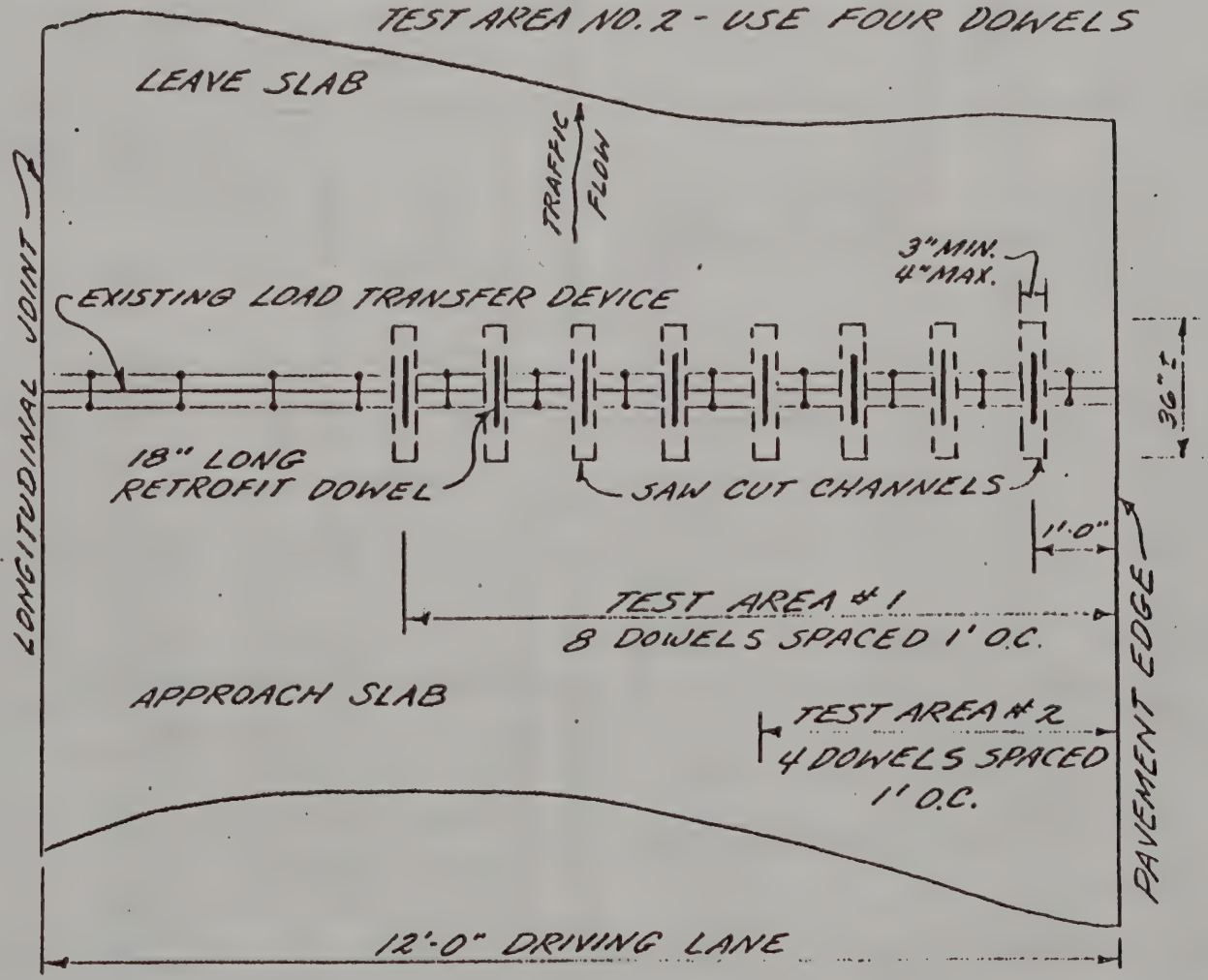


NO SCALE

LOCATION OF CHANNELS FOR DOWEL RETROFIT LOAD TRANSFER DEVICES

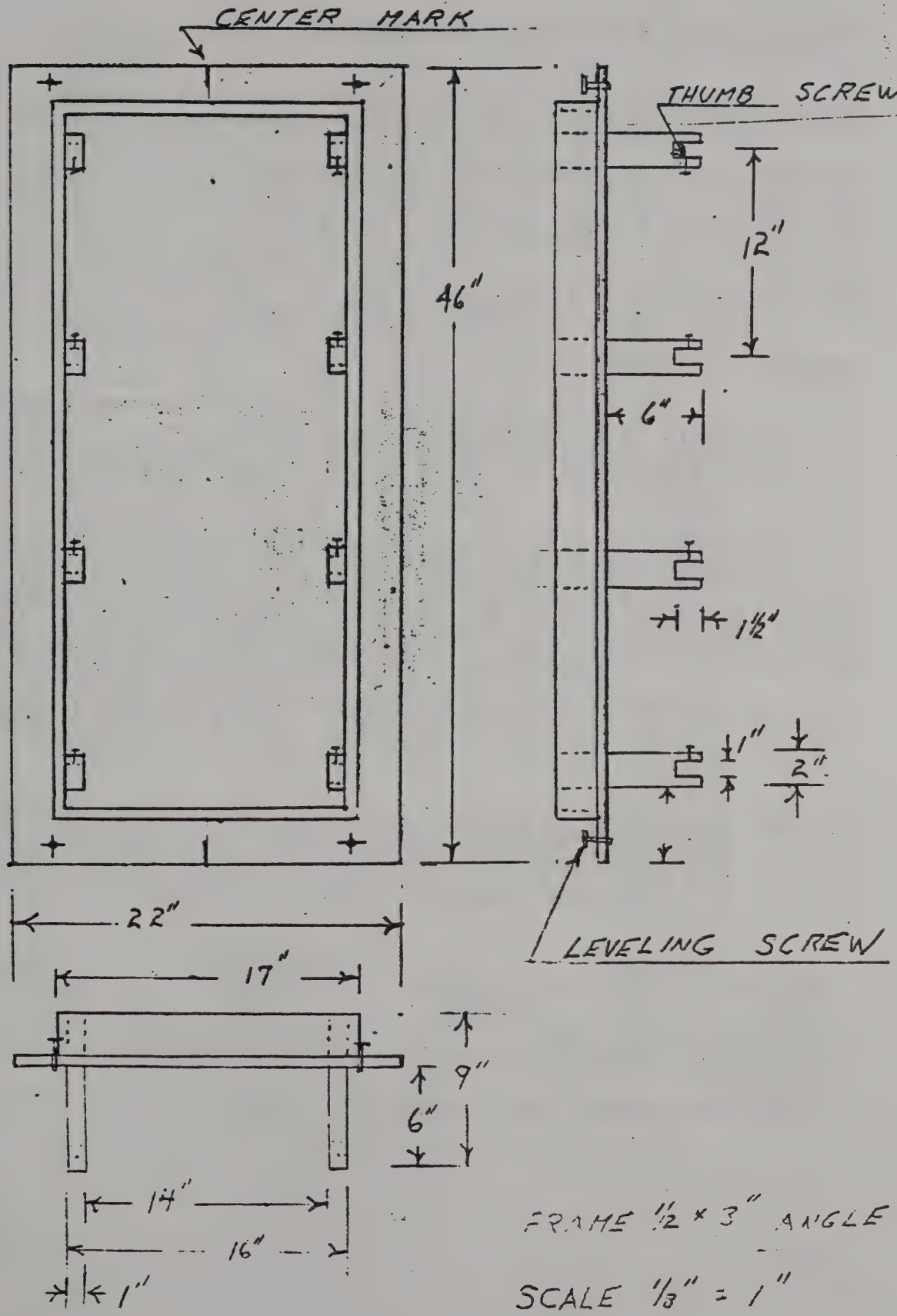
TEST AREA NO. 1 - USE ALL EIGHT DOWELS

TEST AREA NO. 2 - USE FOUR DOWELS



NO SCALE

DOWEL HOLDING DEVICE



FRAME ½ × 3" ANGLE

SCALE ⅛" = 1"

721-20 - RAPID SETTING POLYMER CONCRETE

SCOPE: This specification covers the material requirements for prepackaged, rapid setting, polymer concrete repair material.

GENERAL: Polymer concrete is used to repair portland cement concrete. The brand names of approved materials will appear on the Department's Approved List. Any polymer concrete system not appearing on the Approved List shall be tested and subject to approval before its use is allowed for Department work. All requirements of this specification and any directives shown on the Approved List for these products shall apply.

MATERIAL REQUIREMENTS:

A. Polymer Concrete Mortar - The polymer concrete mortar shall be a two component methyl methacrylate based system. One component shall be a premixed powder consisting of catalyst, fine fillers, and fine aggregate not to exceed 1/16" in size. The other component shall be a methyl methacrylate monomer liquid capable of chemically reacting with the powder component such that the mixture hardens to a completely cured condition within three (3) hours at temperatures between 15F and 100F inclusive. The working life of the mixture shall be a minimum of 10 minutes and its workability shall be consistent throughout the above temperature range. The shelf life of unreacted components, stored at room temperature and in a dry atmosphere, shall be 6 months, minimum.

B. Properties of Cured Polymer Concrete - Neat polymer concrete specimens, when prepared in accordance with the manufacturer's mixing instructions, shall exhibit the following properties when cured for 168±2 hours at 73±5F:

PROPERTY	REQUIREMENT	TEST
Compressive Strength, psi,min.	4000	ASTM C39
Modulus of Rupture, psi,min.	1500	ASTM C580
Elastic Modulus, psi	[0.5 to 1.0]x10^6	ASTM C580
Thermal Expansion Coefficient, in/in/°F	[1.0 to 2.0]x10^{-5}	ASTM C531
Freeze-Thaw Weight Loss, %,max.	4.0	NY 216

C. Aggregate - Aggregate may be added to the pre-packaged polymer concrete to extend its volumetric yield. Unless otherwise approved by the Director, Materials Bureau, the maximum amount of additional aggregate shall be 75% by weight of the powder component included in the batch. The aggregate shall be completely dry, sized from 1/8" to 1/2", and meet the requirements of subsection 703-02, Coarse Aggregate. The use of aggregate designated 703-0204, Crushed Slag, shall not be allowed.

D. Primer - The primer shall be a two component methyl methacrylate resin system capable of enhancing the bond between the polymer concrete and the substrate. It shall have a curing time of 20 to 60 minutes at temperatures between 15F and 100F inclusive.

E. Flammability - The polymer concrete shall not support or sustain combustion within five (5) minutes after mixing.

BASIS OF ACCEPTANCE: Application for material approval shall be submitted to the Director, Materials Bureau. The application shall be accompanied by at least a 50 pound, production run, sample of material. Upon approval, the name of the product will be placed on the Department's Approved List. Products so listed will be accepted at the work site on the basis of the brand name labeled on the container.

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